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MOUSAM RIVER BASIN SANFORD, MAINE

GOODALL-SANFORD DAM ME-00185

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM





DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JUNE 1979

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20. ABSTRACT (Continue on reverse side II necessary and identify by black number)

The dam is about 14 ft. high and 245 ft. long, and has a 213 ft. long uncontrolled free overfall spillway. The dam is assessed to be in fair condition. It is small in size with a high hazard potential. There are various remedial measures which should be implemented by the owner.



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS 424 TRAPELO ROAD WALTHAM, MASSACHUSETTS 02154

OCT 1 5 1979

Honorable Joseph E. Brennan Governor of the State of Maine State Capitol Augusta, Maine 04330

Dear Governor Brennan:

Inclosed is a copy of the Goodall-Sanford Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Agriculture and the Department of Transportation, cooperating agencies for the State of Maine. In addition, a copy of the report has also been furnished the owner, Town of Sanford.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you, the Department of Agriculture and the Department of Transportation for your cooperation in carrying out this program.

Sincerely,

Incl As stated MÁX B. SCHEIDER

Colonel, Corps of Engineers

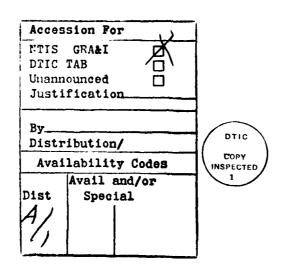
Division Engineer

MOUSAM RIVER BASIN SANFORD, MAINE

GOODALL-SANFORD DAM
ME-00185

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

ME-00185

GOODALL-SANFORD DAM

SANFORD

YORK COUNTY, MAINE

MOUSAM RIVER

December 5, 1978

BRIEF ASSESSMENT

The Goodall-Sanford Dam is a concrete gravity structure. The dam is approximately 14 feet high and 245 feet long, and has a 213-foot long uncontrolled free overfall spillway.

Based on the visual inspection and reports of past operational performance, the Goodall-Sanford Dam is assessed to be in fair condition. Areas of major concern regarding the long-term safety of the dam include deterioration of the concrete at the gated outlet and process water headworks structures, leakage from beneath the east wingwall downstream of the dam, inadequate freeboard between the normal water surface elevation and low areas along the upstream concrete dikes, and the inability of the dam to pass the test flood without overtopping.

Based on the dam's small size and high hazard potential, the spillway test flood is one-half the probable maximum flood (1/2 PMF) which has a peak discharge of 8,500 cfs. The spillway discharge capacity is 26 percent of the test flood. The test flood outflow would overtop the west abutment by 1.6 feet and the east abutment by 0.6 feet.

The recommendations and remedial measures presented in Section 7 should be implemented within 12 months of receipt of this report by Owner. A qualified engineer should be retained to: 1) evaluate the hydrology of the watershed and hydraulics of the dam with respect to the need for increasing the total discharge capacity of the dam; 2) develop provisions for curtailing leakage through the east abutment; 3) develop recommendations for eliminating or relocating catwalks located across the river just downstream of the dam; and 4) develop provisions for curtailing leakage occurring through

the east abutment and to make recommendations to eliminate or relocate the catwalks downstream of the dam. Remedial measures include: 1) repair spalled and deteriorated concrete at the gated outlet and process water headworks structures; 2) remove trees from downstream channel; 3) repair badly corroded gate stems; 4) establish a formal warning system; 5) provide around-the-clock surveillance during heavy runoff periods; 6) institute a program of annual periodic technical inspection.



EDWARP C. JORDAN CO., INC.

Stanker E. Walker, P.E. Project Officer

This Phase I Inspection Report on Goodall-Sanford Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph a. Mc Elroy

JOSEPH A. MCELROY, MEMBER Foundation & Materials Branch Engineering Division

CARNEY M. TERZIAN, MEMBER

Design Branch

Engineering Division

ph W. Finegan FINEGAN, JR., CHAIRVAN

Corney 4. Vazian

Chief, Reservoir Control Center

Nater Control Branch Engineering Division

APPROVAL RECOMMENDED:

Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

	PAGE
LETTER OF TRANSMITTAL BRIEF ASSESSMENT	i iii iv vii ix x
SECTION 1 - PROJECT INFORMATION	
1.1 GENERAL	1-1 1-1 1-3
SECTION 2 - ENGINEERING DATA	
2.1 DESIGN 2.2 CONSTRUCTION 2.3 OPERATION 2.4 EVALUATION	2-1 2-1 2-1 2-1
SECTION 3 - VISUAL INSPECTION	
3.1 FINDINGS	3-1 3-3
SECTION 4 - OPERATING PROCEDURES	
4.1 PROCEDURES	4-1 4-1 4-1 4-1
SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1 EVALUATION OF FEATURES	5-1

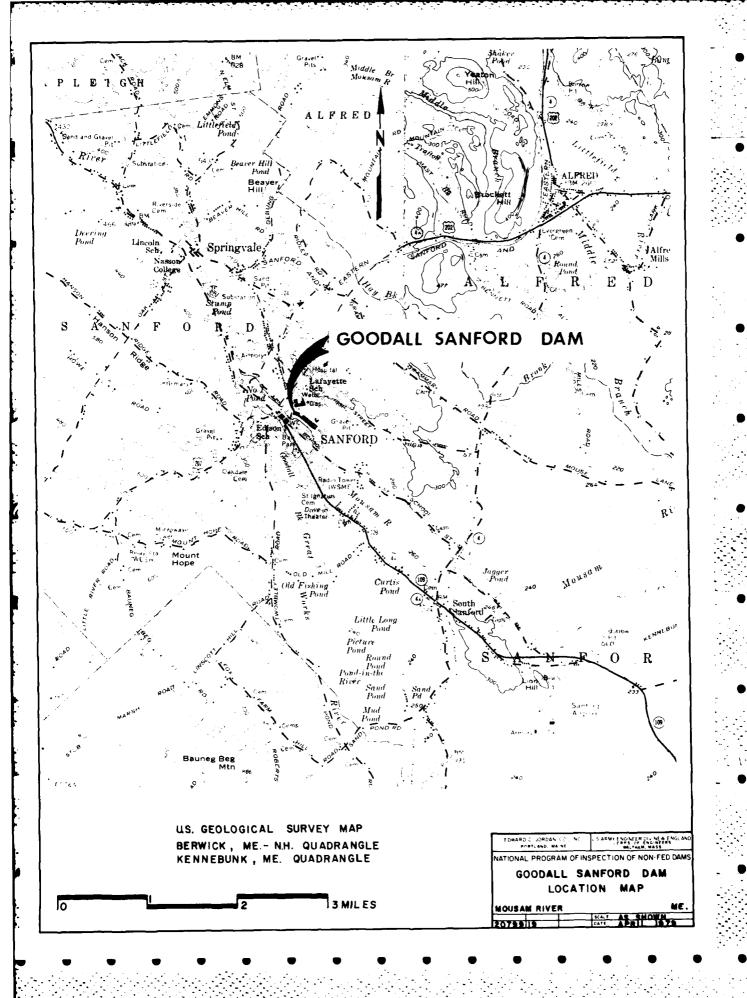
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TABLE OF CONTENTS (Continued)

	SECTION 6 - STRUCTURAL STABILITY	
6.1	EVALUATION OF STRUCTURAL STABILITY	6-1
SECT	ION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURE	S
7.2	DAM ASSESSMENTRECOMMENDATIONSREMEDIAL MEASURES	
APPE	NDICES	
Α	FIELD INSPECTION NOTES	
В	ENGINEERING DATA	
С	PHOTOGRAPHS	
D	HYDROLOGIC AND HYDRAULIC COMPUTATIONS	
Ε	INVENTORY FORMS	



OVERVIEW



PHASE I INSPECTION REPORT

GOODALL-SANFORD DAM

SECTION 1 PROJECT INFORMATION

1.1 GENERAL

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been asssigned the responsibility of supervising the inspection of dams within the New England Region. Edward C. Jordan Co., Inc. has been retained by the New England Division to inspect and report on selected dams in the states of Maine and New Hampshire. Authorization and notice to proceed were issued to Edward C. Jordan Co., Inc. under a letter of December 1, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0017 has been assigned by the Corps of Engineers for this work.

b. Purpose

- (1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.
- (3) To update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF PROJECT

- a. Location. The Goodall-Sanford Dam is located on the Mousam River in the town of Sanford, Maine, N 43°-26.5', W 70°-46.5'.
- Description of Dam and Appurtenances. The Goodall-Sanford Dam is a concrete gravity structure. The dam is approximately 14 feet high and 245 feet long, and has a

213-foot long uncontrolled free overfall spillway. Located near the westerly abutment is a gated outlet works, and located at the easterly abutment is a process water headworks structure. Concrete dike walls extend upstream from both abutments.

Plan, profile and cross-section sketches are presented in Appendix B.

- c. Size Classification. The Goodall-Sanford Dam has a maximum storage capacity of about 400 acre-feet and a height of 14 feet. According to Corps of Engineer's "Recommended Guidelines for Safety Inspection of Dams," a dam with storage capacity less than 1,000 acre-feet and a height less than 40 feet is classified as a small dam.
- d. Hazard Classification. The Goodall-Sanford Dam is classified as a high hazard potential dam. The peak flow from the hypothetical failure of the dam was estimated to be about 6,500 cfs based on the guideline procedures provided by the Corps of Engineers. Failure of the dam would result in river stages of 8 to 9 feet between the two factory buildings which confine the river just below the dam. Considerable damage would be expected at the two buildings with the potential for loss of many lives. Several houses located approximately 1.5 miles downstream of the dam would be flooded to depths of 1 to 3 feet. Several highway bridges located within about 6000 feet of the dam would be overtopped.

e. Ownership.

Current Owner: Town of Sanford

Town Hall

Sanford, Maine

Tel: (207) 324-4121

Contact Person: Anthony Hayes - Town Engineer

Previous Owner: Goodall Mill

Sanford, Maine

Dates: Unknown

f. Operator.

Roy Moses Sanford Highway Department Sanford, Maine Tel: (207) 324-2940

- g. Purpose of Dam. This dam is presently used to provide process and fire protection water to Sutton's Mills and cooling water for York Heel of Maine Inc., located just downstream of the dam.
- h. Design and Construction History. No design or construction data pertinent to this dam was disclosed.
- i. Normal Operating Procedures. No formal operating procedure is followed. The town attempts to maintain an adequate reservoir volume to supply water to the mills located just downstream of the dam.

1.3 PERTINENT DATA

- a. Drainage Area. The drainage area above the Goodall-Sanford Dam is approximately 41 square miles. Approximately 8 percent of the drainage area consists of surface water. The Emery Mills Dam, which impounds Mousam Lake, has a significant regulating effect on the discharge of the Mousam River. The drainage area above the Emery Mills Dam is approximately 29 square miles. The watershed above the Goodall-Sanford Dam is primarily forested, with the exception of the urbanized areas of Springvale and Sanford, Maine. Elevations in the basin vary from 1,230 feet to about 270 feet.
- b. Discharge at Damsite. Releases for flood control or dam maintenance are made at the gated outlet works located near the west abutment and the uncontrolled spillway. The following discharges were estimated assuming a water surface at top of west wingwall (elev. 285.7 MSL), unless otherwise noted.
 - (1) Maximum capacity of gated outlet works (7 foot diameter gate), 520 cfs
 - (2) Maximum flood at damsite is unknown. The flood of March, 1936 produced a peak discharge of approximately 1,300 cfs at the damsite, according to U.S.G.S. Water Supply Paper 798.

- (3) East spillway section at top of dam 2,065 cfs
- (4) West spillway section at top of dam 162 cfs
- (5) Total project discharge at test flood (1/2 PMF) elevation 8,500 cfs at elev. 287.3
- c. Elevation. The mean sea level elevation of the spillway crest is 283.2 ft. as given in U.S.G.S. Water Supply Paper No. 1671.

ITEM ELEVATION (FEET ABOVE MSL)

Top of dam at west abutment	285.7
Low point of easterly concrete dike wall	285.1
Low point of westerly concrete dike wall	284.4
1/2 PMF pool	287.3
East spillway section	283.2
West spillway section	284.0
	Applicable
Streambed at centerline of dam	272.5
Maximum tailwater	Unknown
Normal water surface (east spillway	•
crest)	283.2
Invert of gated outlet	272.9
Approximate invert of water supply	
pipes in gate house at east abutment	274 +
property of the control of the contr	-·· -

d. Reservoir Reach. The following lengths of the reservoir were estimated from U.S.G.S. maps and average streambed slopes.

ITEM	LENGTH (FEET)
Normal water surface pool (elev.	
283.2 MSL)	5000
Top of dam (elev. 285.7 MSL)	5500

e. Storage.

ITEM	STORAGE (ACRE-FEET)
Normal water surface pool (elev. 283.2) Top of west abutment (elev. 285.7) Top of east abutment (elev. 286.7) 1/2 PMF pool	278 413 508 570

f. Reservoir Surface.

ITEM	SURFACE AREA (ACRES)
Normal water surface (elev. 283.2)	52
Top of west abutment (elev. 285.7)	72
Top of east abutment (elev. 286.7)	86
1/2 PMF pool	92

g. Dam.

Type - The dam is a concrete gravity structure.

Length - The length, including the process water headworks structure, is 245 feet.

Height - 14 feet from top of dam to river bed

Top Width - See plan and cross-sections in Appendix B.

Side Slopes - See plan and cross-sections in Appendix B.

Zoning - Unknown.

Impervious Core - N/A.

Cutoff - Concrete placed on bedrock.

Grout Curtain - Unknown

h. <u>Diversion and Regulating Tunnel</u>. Not applicable.

i. Spillway.

Type - The spillway is a broad crested uncontrolled free overfall weir.

Length - west section - 26 feet east section - 187 feet

Crest Elevation - east section - 283.2 MSL west section - 284.0 MSL

Gates - None.

Downstream Channel - The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a highway bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills the bed material consists of sand, gravel and cobbles. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

j. Regulating Outlets.

Invert elev. (MSL) - Outlet Gate 272.9

Size - Outlet Gate - 7-foot diameter

Description - Outlet gate consists of a vertical lift timber gate.

Control Mechanism - Outlet gate - manually operated hoisting equipment.

SECTION 2

ENGINEERING DATA

2.1 DESIGN

No original design data were available for Goodall-Sanford Dam. Some of the hydraulic and hydrologic data used in Appendix D was obtained from the Corps of Engineers Phase I Dam Inspection Reports completed for the Emery Mills Dam (October 1978), River Street Dam (October 1978), and the Mill Street Dam (October 1978), located upstream of the Goodall-Sanford Dam.

2.2 CONSTRUCTION

No engineering data were available regarding construction of the dam.

2.3 OPERATION

No engineering operational data were available.

2.4 EVALUATION

- a. Availability. There are essentially no engineering data or plans available that would be useful in evaluating the integrity of the Goodall-Sanford Dam.
- b. Adequacy. The lack of engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, performance history and engineering judgment.
- c. Validity. Not applicable.

SECTION 3

VISUAL INSPECTION

3.1 FINDINGS

a. General. The Goodall-Sanford Dam is located in a broad flat section of the Mousam River Valley. The dam is a concrete gravity structure with an uncontrolled free overfall spillway. It appears to be founded entirely on bedrock.

b. Dam.

 Structural - The dam is a concrete structure. See Appendices A, B and C for detailed inspection findings, drawings and photographs.

The inspection resulted in the following major findings:

- (a) The dam appears true to line and grade. No evidence of horizontal movement or settlement was observed.
- (b) The spillway sections of the dam appear to be in good condition. The concrete shows evidence of only minor erosion. The horizontal and vertical joints in the spillway are worn but appear tight and no leakage is occurring.
- (c) The concrete in the process water headworks structure at the east abutment is in poor condition (see photographs 5 and 6). Severe spalling, exposing reinforcing steel, has occurred on the upstream faces. The downstream face shows severe surficial cracking indicating a potential lime-silica reaction within the concrete.
- (d) The concrete in the control outlet section is in fair to poor condition (see photographs l and 2). Severe spalling has occurred particularly within the outlet conduit where joints are open and leakage is occurring.

- (e) No seepage or leakage was observed along the downstream face of the dam. Leakage is occurring from beneath the east wingwall downstream of the dam. The source of this leakage could not be determined.
- (2) Hydraulics The reservoir water surface is primarily controlled by the free overfall spillway. A 7-foot diameter gated outlet, located near the west abutment, can be used to drain the impoundment if required. Although not operated during the field inspection, the gate works appeared in fair condition and are believed to be operable. The concrete of the outlet channel is deteriorated in some areas. Operation of the gated outlet at the present time would result in further damage to the outlet channel. Low concrete dike walls extend upstream of the dam on both the east and west shorelines. Three water supply inlets are operated from the gate house on the east abutment. The three pipelines supply process and cooling water to nearby factories. At the time of visual inspection, the reservoir level was about 0.05 feet above the east spillway crest.
- c. Appurtenant Structures. The control outlet consists of a 7-foot diameter sluiceway closed by a vertical lift timber gate. The gate and operating mechanism appear to be in fair condition. The lifting stems on the gate are badly corroded but intact. During periods of high flow, there is not suitable access to the operating mechanism of the control outlet.
- d. Reservoir Area. The reservoir shoreline is primarily urbanized except at the headwaters of the reservoir which is generally wooded. U.S. Route 202 crosses the reservoir approximately 600 feet upstream of the dam. The bridge causes a constriction of the reservoir at its crossing. With the exception of the Route 202 bridge, the approach to the spillway is clear and unobstructed. Ground slopes above the reservoir are slight to moderate and the potential for slope failures appeared minimal.
- e. Downstream Channel. The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a highway bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. The stream channel between the mill buildings is about 45 feet wide. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills, the bed

material consists of sand, gravel and cobble. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

3.2 EVALUATION

Based on the visual inspection, the dam appears to be in fair condition. The concrete in the control outlet and process water headworks areas is in fair to poor condition with cracking and spalling evident. The catwalks crossing the downstream channel and connecting the mill buildings each side of the channel could collect debris and thus cause rapid flooding of street level areas within the mill buildings. As outlined in Section 7, rehabilitative construction and maintenance is necessary to assure the long-term safety of the structure.

SECTION 4

OPERATING PROCEDURES

4.1 PROCEDURES

The outlet gates are operated manually to control the reservoir surface elevation. The water supply inlets at the east abutment provide process and cooling water to the mills just downstream.

4.2 MAINTENANCE OF DAM

Reportedly, maintenance to the dam is performed on an asneeded basis. There are no maintenance records available.

4.3 MAINTENANCE OF OPERATING FACILITIES

The outlet gate and operating mechanism are generally in fair condition. However, the lifting stems on the gate are badly corroded. The gate reportedly is operated periodically to ensure that it remains operable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

No warning system is known to be in effect.

4.5 EVALUATION

The Goodall-Sanford Dam operating equipment is generally in fair condition. Although no regularly scheduled program of maintenance is in effect, maintenance is reportedly performed on an as-needed basis. No formal warning system for either high water or structural distress is in effect at the dam.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. General. The Goodall-Sanford Dam is a concrete gravity structure with a free overfall spillway running almost the entire length of the dam. Concrete dike walls extend upstream of the dam along both the east and west shorelines. The impounded water is primarily used for process and cooling water at nearby mills. The discharge of the Mousam River above the dam is affected by the regulation of Mousam Lake by the Emery Mills Dam. Water level is normally kept at or near spillway crest at the Goodall-Sanford Dam.
- <u>b.</u> <u>Design Data</u>. No original hydrologic or hydraulic design data were available.
- c. Experience Data. No information regarding specific overtopping events or other notable hydrologic occurrences were disclosed. Damage caused by previous overtopping events was not observed. As reported in U.S.G.S. Water Supply Paper No. 798, the flood of March, 1936 produced a discharge of 1,300 cfs on the Mousam River at Sanford, Maine.
- d. Visual Observations. Water level at the Goodall-Sanford Dam can be regulated only by the gated outlet. The concrete of the gated outlet discharge channel is deteriorated (see photographs 1 and 2). The crest and downstream face of the spillway are in good condition. No significant scour was noted at the toe of the dam. Only about 2 feet of freeboard exists between normal water surface easterly of spillway crest and the top of the concrete dike walls along the east and west shores.
- e. Test Flood Analysis. The Goodall-Sanford Dam is classified as having a high hazard potential. Based on Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams," the spillway test flood is one-half the probable maximum flood (PMF). Due to the amount of regulation upstream, the Mousam River is considered as having a low runoff potential. The drainage area above the Goodall-Sanford Dam is about 41 square miles. The

discharge of the Mousam River is regulated by the Emery Mills Dam on Mousam Lake. The drainage area above the Emery Mills Dam is about 30 square miles. Phase I Dam Safety Inspection Reports have been completed for three dams upstream of the Goodall-Sanford Dam, including the Emery Mills Dam. Using the results of the 1/2 PMF development for the upstream dams, the test flood inflow to the Goodall-Sanford Reservoir was estimated to be 8,500 cfs (see Appendix D). The surcharge storage capacity of the Goodall-Sanford Dam would not reduce the 1/2 PMF peak flow due to routing effects. The test flood would therefore overtop the west abutment (elev. 285.7) by 1.6 feet and the east abutment (elev. 286.7) by 0.6 feet. The low areas of the concrete dike walls would be overtopped by 2.9 feet. The spillway discharge capacity of the dam is approximately 26% of the 1/2 PMF peak flow.

f. Dam Failure Analysis. To determine the hazard classification of the Goodall-Sanford Dam, the potential impact of failure of the dam was assessed. The failure analysis relied upon the Corps of Engineers "rule of thumb" guidance. The hazard potential was determined by calculating peak discharge rates which might occur downstream of the dam due to a breach of the spillway section.

The flood peak at the dam from failure was estimated to be 6,500 cfs. It would take the reservoir 1 to 2 hours to empty. The peak flow would result in river stages of 8 to 9 feet between the two mills located just downstream of the dam. The possibility exists of clogging the stream channel between the mills due to debris catching on to the catwalks and catwalk support members. This would result in raising downstream water surfaces. Considerable damage would be expected at the mills and the potential for loss of life would be high. Just prior to failure, river stages between the two mills would be approximately 4 feet.

Some flooding would occur in a residential area located approximately 1.5 miles downstream of the dam in the area of School St. Approximately 5 dwellings would be flooded to depths of 1 to 3 feet. Prior to failure, with spillway discharging at full capacity, no flooding would be expected in this area.

Based on the information discussed above, the Goodall-Sanford Dam is judged to have a high hazard potential. Being a concrete gravity dam with an overfall spillway and concrete dike walls, the Goodall-Sanford Dam is considered to be generally resistant to deterioration by overtopping.

SECTION 6

STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations. Based on the visual observations, the Goodall-Sanford Dam appears to be in fair condition. The spillway sections appear to be in generally good condition but the gated outlet and process water headworks are in poor condition (see photographs 5 and 6). The concrete in these areas is severely spalled, joints are open, and surficial cracking is apparent. Leakage is occurring through joints in the gated outlet conduit. Leakage was also observed to be occurring from beneath the east wingwall downstream of the dam.
- b. Design and Construction Data. No data concerning original design or construction of the Goodall-Sanford Dam was disclosed in this investigation.
- c. Operating Records. None available.
- d. Post-Construction Changes. Since its construction, reported to be in 1911, no modifications are known to have been made.
- e. Seismic Stability. The dam is located in Seismic Zone
 No. 2 and in accordance with recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Condition. Based on the visual inspection and performance history, the Goodall-Sanford Dam is assessed to be in fair condition. The inspection identified the following major items of concern:
 - (1) Deterioration of concrete in gated outlet and process water headworks (see photographs 1, 2, 4, and 5).
 - (2) Leakage from beneath the east wingwall below the dam.
 - (3) The dam is not capable of passing the test flood (1/2 PMF) without overtopping. There is inadequate freeboard between the normal water surface elevation and the low areas of the concrete dikes to contain the test flood above the dam.
 - (4) Potential for collection of debris and rapid flooding of the immediate area at the catwalks across the downstream channel, connecting the mill buildings each side of the channel.
 - (5) Lack of suitable access to control outlet.
- b. Adequacy of Information. The information available is such that the assessment of the condition of the dam must be based primarily on the visual inspection, the past operational performance of the dam, and engineering judgment.
- c. Urgency. The recommendations and remedial measures outlined in 7.2 and 7.3 below should be implemented within 12 months after receipt of this report by the owner.
- d. Need for Additional Investigation. Additional investigation is not considered necessary for the current assessment.

7.2 RECOMMENDATIONS

An engineering evaluation of the watershed hydrology and dam hydraulics should be undertaken to determine the need for increased discharge capacity and need for increasing the height of the existing concrete dike walls to provide sufficient freeboard. The findings of that evaluation should be implemented as found necessary.

A qualified engineer should be engaged to develop provisions for curtailing leakage occurring through the east abutment and to make recommendations to eliminate or relocate the catwalks downstream of the dam.

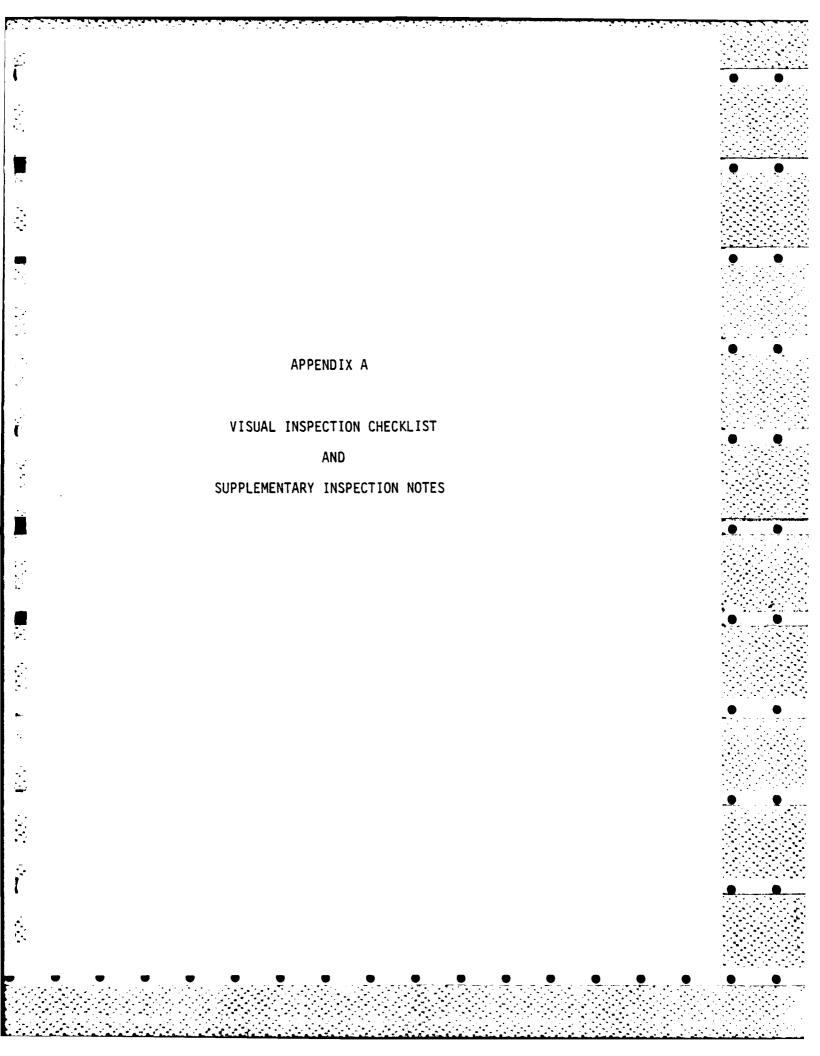
The need and appropriate construction details for a facility to provide access to the gated outlet during high flow should be evaluated and developed by a qualified engineer and implemented as found necessary.

7.3 REMEDIAL MEASURES

- a. Operating and Maintenance Procedures. A program of regular inspection and maintenance of the dam should be implemented and recorded. The following specific maintenance and operating procedures should be implemented:
 - (1) Repair the spalled and deteriorated concrete in the gated outlet and process water headworks.
 - (2) Remove trees in downstream channel.
 - (3) Repair or replace badly corroded gate stems.
 - (4) Provide around-the-clock surveillance during periods of anticipated high runoff.
 - (5) Develop a formal warning system and implement its use in the event of an emergency.
 - (6) Have inspections of the dam made by qualified engineers once every year.

7.4 ALTERNATIVES

None.



VISUAL INSPECTION CHECKLIST PARTY ORGANIZATION

PROJECT Goodall-Sanford Dam	DATE 12/5/78
	TIME A.M.
	WEATHER Partly cloudy,
	W.S. ELEV. U.S. DN.S.
PARTY:	
1. Stephen Cole	6
2. <u>John Devine</u>	7
3. Scott Decker	8
4. John Kimble	9
5. <u>Charles Goodwin</u>	10
PROJECT FEATURE	INSPECTED BY REMARKS
1. Geotechnical	Cole
2. Structural	Cole, Devine, Decker
3. Hydraulics/Hydrology	Devine
4. <u>Civil</u>	Decker
5. Survey	Kimble, Goodwin
6. Photography	Decker, Devine
7	
Review Inspection	S. Walker, C. Horstmann
12/5/78 No significan	t differences noted during inspection of
12/5/78.	
NOTE: See Supplementary Inspection N	otes Following Checklist

A-1

Goodall-Sanford Dam

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam	DATE12/5/78
PROJECT FEATURE Embankment	NAMECole
DISCIPLINE Geotechnical	NAME
AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	NOT APPLICABLE
Movement or Settlement of Crest	No Embankment
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Vegetation	

AREA EVALUATED

CONDITIONS

DAM EMBANKMENT (cont.)

Rock Slope Protection - Riprap Failures

Unusual Embankment or Downstream Seepage

NOT APPLICABLE No Embankment

Piping or Boils

Foundation Drainage Features

Toe Drains

Instrumentation System

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam	DATE 12/5/78	• '
PROJECT FEATURE Intake Channel/Structure	NAMECole, Devine	
DISCIPLINE <u>Structural</u> , <u>Geotechnical</u> Hydraulics/Hydrology	NAMEDecker	
AREA EVALUATED	CONDITION	
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE		<u> </u>
a. Approach Channel		•
Slope Conditions	Concrete retaining walls	
Bottom Conditions	Substantial silt, no debris	
Rock Slides or Falls	None	
Log Boom	None at major outlet, log above process water outlet structure	
Debris	None	- ,
Condition of Concrete Lining	N/A	
Drains or Weep Holes	N/A	
b. Intake Structure		•
Condition of Concrete	Spalled and cracked	
Stop Logs and Slots	None	·.·
Dehris Screen	None	<u>-</u>

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam PROJECT FEATURE Control Tower		2/5/78 Cole, Devine	
DISCIPLINE Structural/Geotechnical Hydrology/Hydraulics	-	Decker	
AREA EVALUATED		CONDITION	
OUTLET WORKS - CONTROL TOWER	Control Outlet	Process Water Headworks	
a. Concrete and Structural			
General Condition	Spalled	Spalled	. •
Condition of Joints	Fair	Fair	
Spalling	Severe	Severe	
Visible Reinforcing	None	Yes	
Rusting or Staining of Concrete	Lime stain	Lime stain and rust	
Any Seepage or Efflorescence	None	None	in the state of th
Joint Alignment	Okay	0kay	
Unusual Seepage or Leaks in Gate Chamber	N/A	N/A	
Cracks	Surficial	Surficial	
Rusting or Corrosion of Steel	None	None	
b. Mechanical and Electrical			
Air Vents	N/A	N/A	
Float Wells	N/A	N/A	
Gate Hoist	Gate works good	Hoist for inlet screens	
Elevator	N/A	N/A	

AREA EVALUATED		CONDITIONS		
OUTLET WORKS - CONTROL TOWER (Cont.)	Control Outlet	Process Water Headwork	<u></u> s	
Hydraulic System	N/A	N/A	·.	
Service Gates Emergency Gates	Timber gate okay	3 valves, 36", 24", 30 good)"	
Lightning Protection System	N/A	N/A	•	
Emergency Power System	N/A	N/A	•	
Wiring and Lighting System	N/A	N/A		

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam	DATE12/5/78		
PROJECT FEATURE Conduit	NAMECole, Devine		
DISCIPLINE Geotechnical, Structural Hydraulics/Hydrology	NAMEDecker		
AREA EVALUATED	CONDITION		
OUTLET WORKS - TRANSITION AND CONDUIT	Control Outlet		
General Condition of Concrete	Spalled, cracked, open joints		
Rust or Staining on Concrete	Lime stain, some rust		
Spalling	Severe spalling		
Erosion or Cavitation	Erosion of spalled area		
Cracking	Along joints, sides of conduit		
Alignment of Monoliths	Horizontal joints open l" +		
Alignment of Joints	Okay		
Numbering of Monoliths	N/A		
	Heavy leakage into conduit throug cracks and joints.		
	Could not inspect conduit below process water headworks.		

PERIODIC INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam	DATE12/5/78
PROJECT FEATURE Outlet Structure/Channel	NAMECole
DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics	NAME Devine, Decker
AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Spalled, cracked, open joints
Rust or Staining	Some staining
Spalling	Severe
Erosion or Cavitation	Only of spalled areas
Visible Reinforcing	None
Any Seepage or Efflorescence	None
Condition at Joints	Poor, open somewhat
Drain holes	None
Channel	No scour
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Bridge restriction downstream

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam	DATE 12/5/78
PROJECT FEATURE Spillway	NAMECole
DISCIPLINE <u>Geotechnical</u> , <u>Structural</u> Hydrology/Hydraulics	NAMEDecker, Devine
AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good - Note: Bridge restriction upstream
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Some silt, no debris
b. Weir and Training Walls	
General Condition of Concrete	Fair to good
Rust or Staining	None observed
Spalling	Minor
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None observed
Drain Holes	One 4" pipe near east end of
c. Discharge Channel	spillway
General Condition	Bedrock, island w/trees in channel
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	On island
Floor of Channel	Bedrock, no scour
Other Obstructions A-9	Bridge downstream Goodall-Sanford Dam

SUPPLEMENTARY INSPECTION NOTES

GOODALL-SANFORD DAM SANFORD, MAINE

APPENDIX A

I. CONCRETE STRUCTURES IN GENERAL

- a. Concrete Surfaces. The concrete surfaces of the Goodall-Sanford Dam range from fair to very poor. Around the process water headworks and the gated outlet section of the dam, deep spalling has occurred (see photographs 1, 2, 4, and 5). At the process water headworks, the spalling has progressed to a point where reinforcing steel is exposed and the wingwalls of this section are considered to be in very poor condition. The surface of the spillway shows evidence of some erosion and minor spalling. In other areas of the dam, particularly the wingwalls, there is substantial cracking and substantial lime stain and some rust stain. The surficial cracking appears to be related to a lime silica reaction in the concrete.
- b. Structural Cracking. There appear to be no major structural cracks in the dam structure. It is noted above that substantial surficial cracking has occurred in many areas.
- c. Movement, Horizontal and Vertical Alignment. The entire dam structure, including the wingwalls, appear to be true to line and grade. No evidence of horizontal or vertical movement was noted.
- d. Junctions. The junctions between the abutments and the wingwalls and the embankment behind the wingwalls were found to be in good condition with no evidence of settlement or seepage.
- e. Drains. One 4-inch diameter drain was found at the toe of the spillway section on the easterly end of the dam near the process water headworks. It was found to be open and flowing about 100 gpm.

- f. Water Passages. The surface of the spillway was found to be in generally good condition with some erosion and minor spalling of the concrete surface. The interior surface of the gated outlet conduit is in very poor condition. The concrete has a very soft texture and there are areas deeply spalled. Also, joints at each side of this conduit are open and leakage is occurring through the westerly side of the conduit.
- g. Seepage or Leakage. No seepage or leakage was observed along the downstream face of the dam. Some leakage (about 20 gpm) was observed beneath the downstream wingwall at the east end of the dam. The source of this leakage could not be determined.
- h. Monolith Joints & Construction Joints. The spillway section of the dam and the gated outlet section was apparently placed in at least four lifts. The horizontal joints were found to be open somewhat with erosion along the joints. The vertical joints in the spillway section of the dam were also in good condition with no signs of movement or leakage. Some erosion and wear has occurred along these joints.
- i. Foundation. The dam appears to be founded entirely on bedrock. No undermining at the toe of the dam was evident and no foundation distress was evident.
- j. Abutments. No evidence was found in the visual inspection to indicate instability or weathering of the abutments. The abutments appear to be founded directly on bedrock and no movement or evidence of substantial seepage or leakage was evident.

2. EMBANKMENT STRUCTURES

The only embankment at the Goodall-Sanford Dam is behind the concrete wingwalls which run upstream from the abutments of the dam. The embankment behind both wingwalls was found to be in good condition with no evidence of settlement or instability.

3. SPILLWAY STRUCTURES

The spillway at the Goodall Dam is a concrete weir which extends from the process water headworks to the west abutment, being interrupted only by the gated outlet structure.

- a. Control Gates and Operating Machinery. The spillway at the Goodall-Sanford Dam is uncontrolled.
- b. Unlined Saddle Spillways. None.
- c. Approach and Outlet Channels. The approach channel to the spillway is clear and unobstructed. A highway bridge, located about 800 feet upstream of the dam, restricts the channel. There is some evidence of minor silting upstream of the spillway, however, no debris was apparent (see photograph 5). The outlet channel from the spillway is the bedrock channel downstream of the dam. The bedrock is high near the midpoint of the spillway and in this area there are many trees and brush (see photograph 7). The wingwalls downstream of the dam constrict the channel substantially to the two bridges located approximately 150 feet downstream from the spillway.

4. GATED OUTLET WORKS

The gated outlet works consist of a 7-foot diameter conduit which is gated by a vertical lift timber gate.

- a. <u>Intake Structure</u>. The concrete around the inlet structure appears to have spalled and is somewhat deteriorated. The inlet appears to be clear and unobstructed.
- b. Operating and Emergency Control Gates. The hoisting equipment for the gated outlet appears to be in good condition except the gate stems, which show a substantial amount of corrosion at the water line. It was reported by the dam operator that the gate has been frequently operated in the past, however, the gate was not operated during inspection. The downstream face of the gate was inspected and was found to have some surficial deterioration. Little or no leakage was occurring.
- c. Conduits, Sluices and Passageways. The interior surface of the outlet conduit consists of a steel pipe extending approximately four feet from the gate face and a concrete conduit beyond that. The interior surface of this conduit is severely spalled and has two open joints, one of which is leaking at approximately 50 gpm. Some erosion of the concrete has occurred, particularly in areas where spalling has started.
- d. Stilling Basin. The stilling basin downstream of the

outlet sluiceway consists of the bedrock channel. No serious erosion or scour could be seen.

- e. Approach and Outlet Channels. The approach channel to the gated outlet appears to be clear and unobstructed. The outlet channel also appears to be clear and unobstructed, except for the bridges downstream.
- f. <u>Drawdown Facilities</u>. The gated outlet appears to be capable of providing complete drainage of the pond during low to average flows.

5. RESERVOIR

- a. Shoreline. The potential for slope failure or earth slides appeared minimal. The reservoir shoreline is primarily urbanized with the exception of the headwaters area which is wooded. U.S. Route 202 crosses the reservoir approximately 600 feet above the dam. The bridge causes a constriction of the reservoir.
- b. Sedimentation. The extent of sedimentation in the reservoir could not be observed during the field inspection. However, sediment accumulation does not appear to impede flow to the spillway.
- c. Potential Upstream Hazard. A house located near the dam in the west bank would be flooded to a depth of about 5 feet during the test flood. The basement of the house is above the spillway crest.
- d. Watershed Runoff Potential. No significant changes in watershed runoff potential are expected to occur in the near future.

6. DOWNSTREAM CHANNEL

The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a road bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills, the bed material consists of sand, gravel and cobble. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

7. OPERATING AND MAINTENANCE FEATURES

- a. Reservoir Regulation Plan. No formal plan was disclosed.
- b. Maintenance. It appears that maintenance is done to the dam on an as-needed basis. The operating equipment for the outlet gate appears to be in generally good condition, except the gate stem which has a substantial amount of corrosion at the normal water line. Little or no maintenance has been done to the concrete surfaces of the structure. These areas of the dam are presently in need of maintenance.

APPENDIX B

ENGINEERING DATA

This appendix lists the engineering data collected either from project records or other sources of data developed as a result of the visual inspection. The contents of this appendix are listed below.

<u>Appendix</u>	<u>Description</u>					
B1	General Project Data					

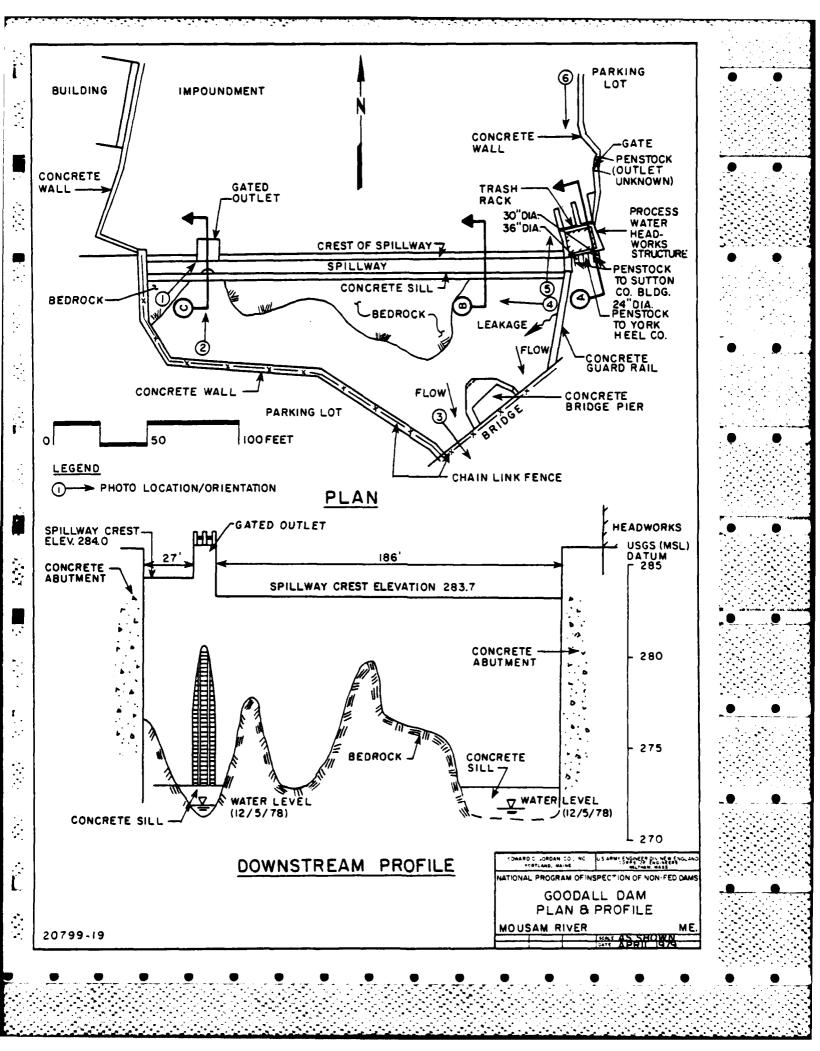
APPENDIX B-1

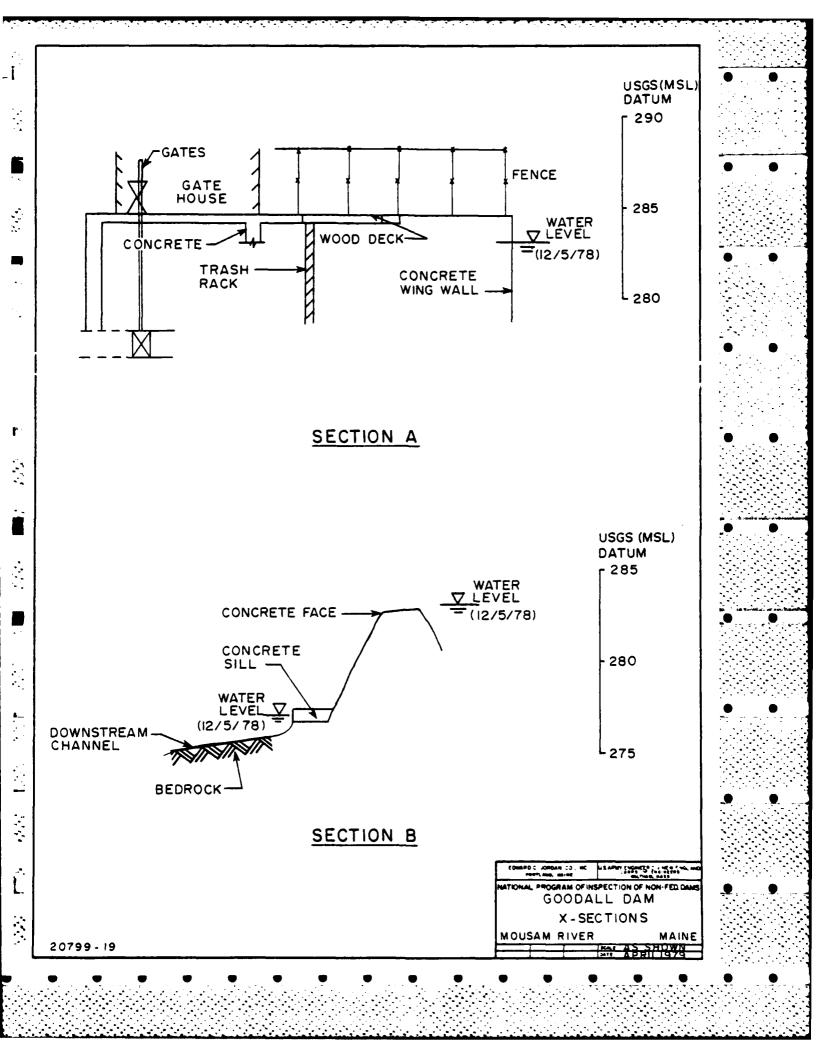
GENERAL PROJECT DATA

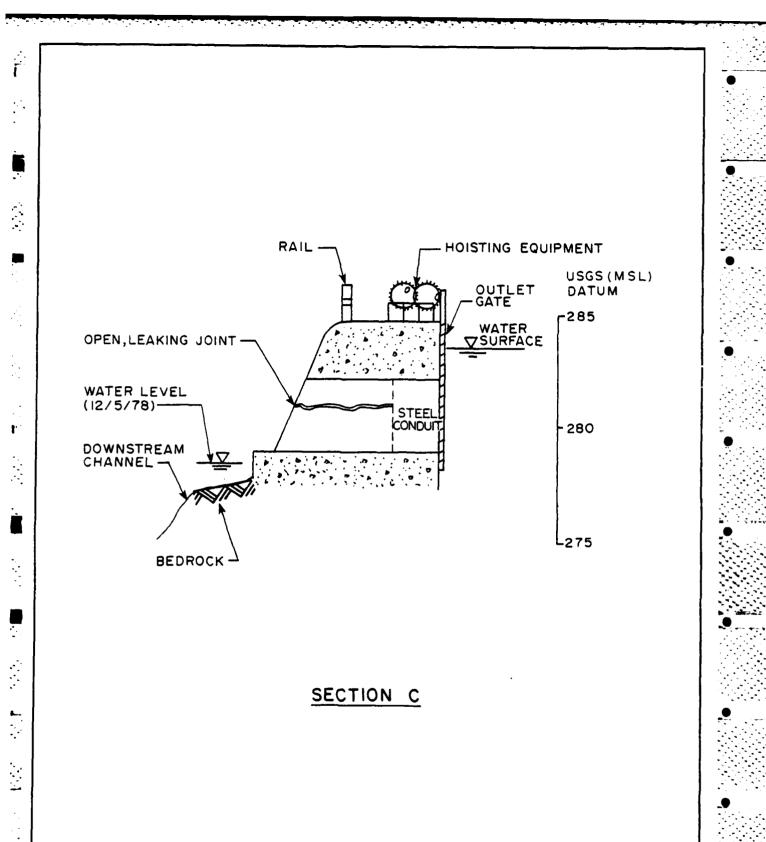
The following material is available at the office of the U.S. Army Corps of Engineers, 424 Trapelo Road, Waltham, Massachusetts.

A. Copy of the Corps of Engineers "National Dam Inspection Program, Phase I Inspection Reports," for Emery Mills Dam, October, 1978, and River Street Dam, 1978.

The following plan, profile and cross-sections of the dam were developed from a limited stadia survey performed during visual inspection, field notes taken by inspection team members, and photographs taken during the visual inspection. Approximate U.S.G.S. elevations based on mean sea level were calculated by noting the dam's location on a U.S.G.S. topographic map.







PATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

GOODALL DAM

X - SECTION

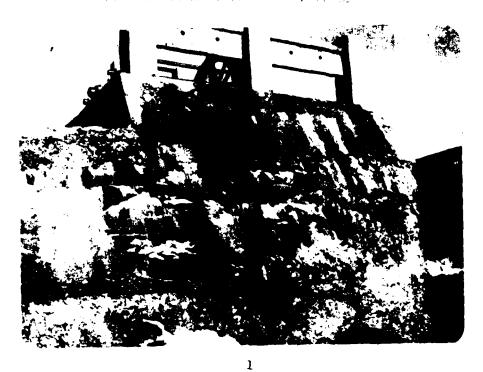
MOUSAM RIVER MAINE

20799-19

APPENDIX C

PHOTOGRAPHS

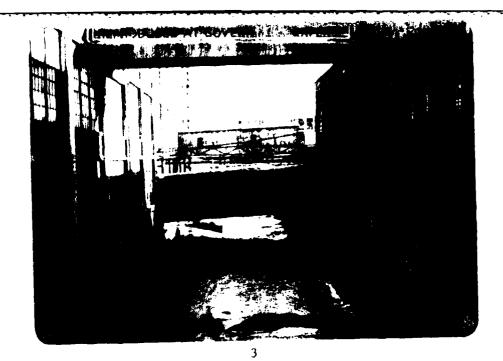
The following are photographs referenced in this report. See Sheet B-1 for photograph locations and orientations.



OUTLET GATEWORKS



2 OUTLET GATE

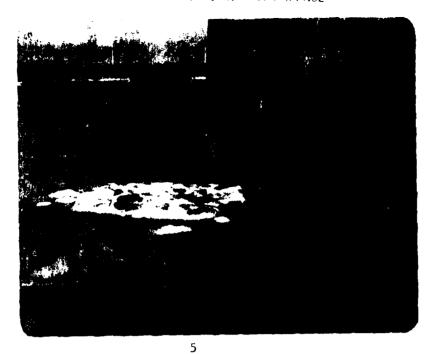


DOWNSTREAM CHANNEL RESTRICTION



DOWNSTREAM FACE

REPRODUCED AT GOVERNMENT EXPENSE



UPSTREAM VIEW



CATED HEADWORKS

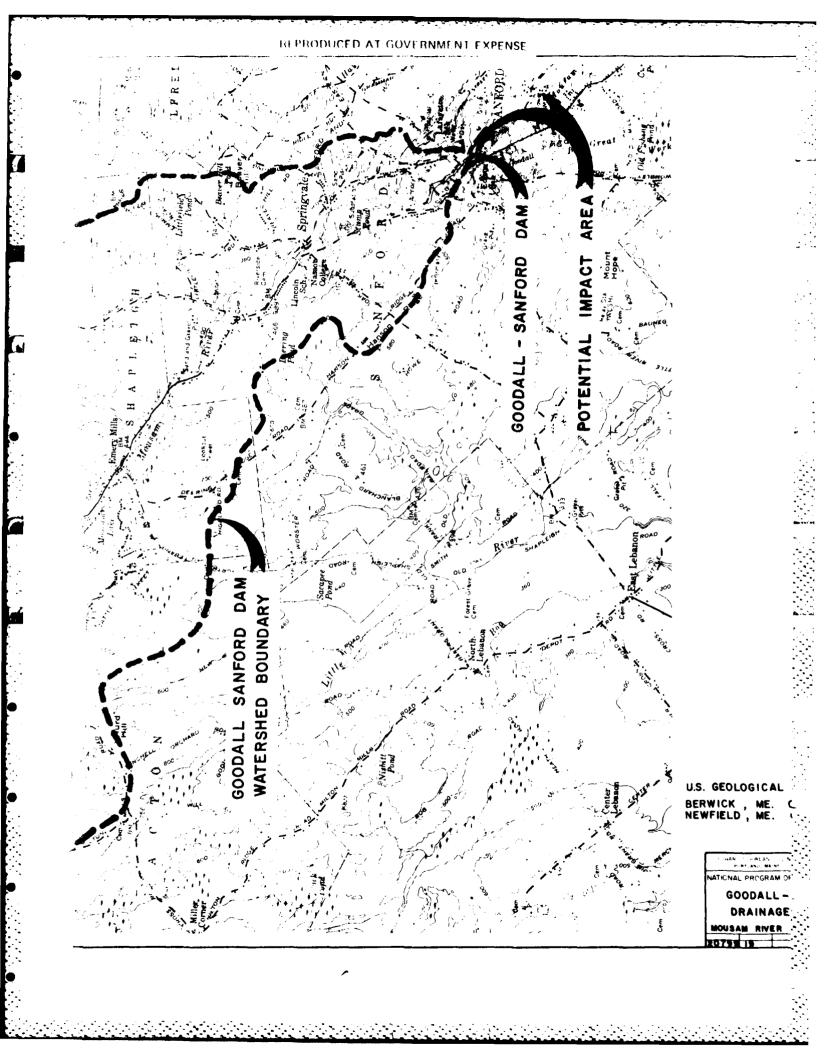


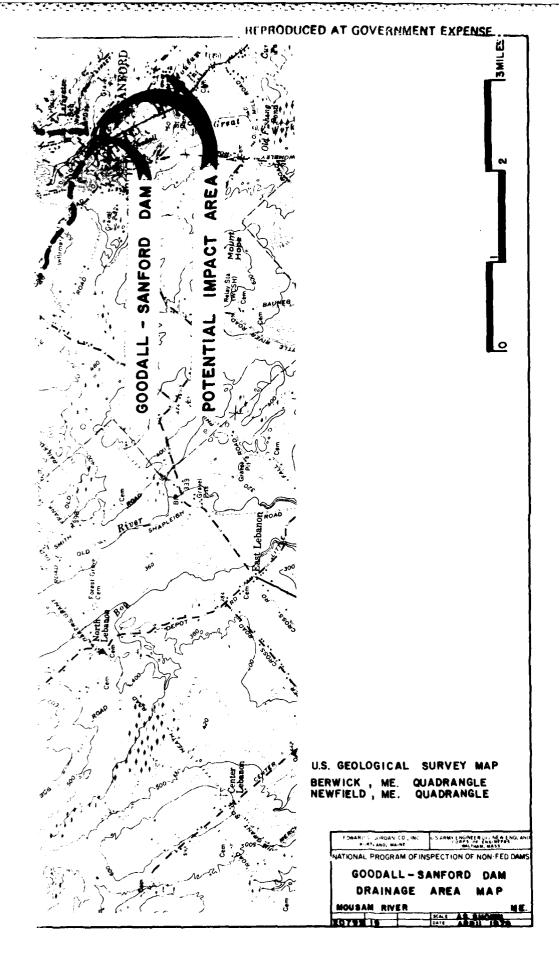
VIEW OF DOWNSTREAM CHANNEL

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Hydrologic computations pertinent to this investigation are attached. The following figure shows the Mousam River watershed at the Goodall-Sanford Dam.





PROJECT GODALL - SANFORD DAM	COMP BY THE \$JJD	JOB NO. 20799 - 19
HYDRAULICS		DATE 2-13-79

DISCHARGE CAPACITY AT DAM :

MAIN

TIE TO MEAN SEA LEVEL DATUM - SPILLWAY CREST AT SURVEY DATUM = 100.0 FT = 283.2 FT MSL (OBTAINED FROM USGS WATER SUPPLY PAPER No. 1671).

A. MAIN SPILLWAY - NON-GATED FREE OVERFALL SPILLWAY WITH

(EAST SPILLWAY BREADTH 3 3.0 FT., ASSUME SPILLWAY IS A

SECTION) BROAD-CRESTED WEIR. "C" VALUES FROM KING &

BRATER "HANDBOOK OF HYDRAULICS", TABLE 5-3,

SIXTH EDITION

	Mean Sea Level Elev.	SURVEY DATUM ELEV	Н	c	L_		
CREST	283.2 284.0	0.001	0.8	2.67	186	355	·-····································
The second design of the second secon	285.0 286.0	101.8	1.8	2.68	19	1,204	V
	288.0	104.8	3.8 4.8 5.8	3.03 3.32 3.32		4,175 6,494	
	290.0	106.8	6.8	3,32 3,32	•••	8,626 10,950 13,452	

B. SPILLWAY SECTION AT WEST END OF DAM - SAME AS ABOVE WITH BREADTH 23.0 FEET

	Mean sea Leyel Elev	Survey Datum Elev	Н	C	L	a
Crest .	284.0	100.8	0	1.	27	0
CEC I	285.0	101.8	1.0	2.65	61	72
	286.0	102.8	2.0	2.72	to .	208
				2,92	•	410
	288.0	104.8	4.0	3.07	14	663
		1	1	3.32	**	1,002
	290.0	106.8	6.0	•	R	1,317
	291.0	107.8	17.0	*	•	1,660

D-2 Goodall-Sanford Dam

PROJECT	COMP BY	· ·
GOODALL- SANFORD DAM	9.11	20799 - 19 DATE
HYDRAULICS		2-13-79

C. EAST WINGWALL SECTION WITH CREST AT ELEV 285.1 FT MSL (SURVEY DATUM = 101.9 FT) - BROAD CRESTED WEIR WITH BREADTH = 1.5 FT

	MS L ELEV	SURVEY ELEV	Н	c	L	Q
CREST	285.1 286.0	101.9	0	2.71	20.	0
	20010		1.9	3.05	# · · · · · · · · · · · · · · · · · · ·	160
	288.0	104.8	2.9 3.9	3.32	4	<i>3</i> 28
— — — Paris	290.0		4.9.		4	720
	291.0	107.8	5.9	<u>l </u>		952

D. EAST WINGWALL SECTION WITH CREST AT ELEV 285.3 FT MSL - BROAD CRESTED WER WITH BREADTH = 1.5 FT

	MSL	SURVEY			1		
	ELEV	ELEV	Н	C	L	Q_{\perp}	 ele - en a / , appara
CREST	285.3	1.501	_0		217	0	
	286.0	102.8_	10.7	2.66	"	338	
		103, 8	1.7	3.07	"	1,477	
	288.0		2.7_	3.30	•	3,177	
		105.8	3.7	3.32	"	5,127	· ·
	290.0		4.7	"	. "	7,340	
	291.0	107.8	5.7	1		9,804	

E. EAST WINGWALL SECTION AT 286.3 FT

MSL_ ELEV	Survey	Н	C	L	Q	
 286.3 287.0 288.0	103.1 103.8	0.7	2.66 3.07 3.30	15	0 23 102 220	
290.0 291.0	167.8	3.7 4.7	3.32 3.32		354 507	

D-2 Goodall-Sanford Dam

	COMP BY	JOB NO. 20799 - 19
HYDRAULICS	CHK BY BTB	DATE 2-15-79

F. EAST WINGWALL SECTION WITH CREST ELEV AT 286.7 PT (BREADH = 1.5)

	MSL	Survey Eley	н	C	L	Q	
	286.7	103.5			50	0	
	287.0	103.8	0.3	2.63	,	22	
	Z88.0		1.3	2.89		214	
		105.8	2.3	3.12	h	544	
-	290.0 291.0	107.8	3.3	3.32	.,	1,480	

G. WEST WINGWALL SECTION WITH CREST ELEV AT 284.4 FT (BREADTH=

 MSL	SURVEY	<u> </u>	<u> </u>		1	
 ELEV	ELEV	Н	C	-	Q	
 284.4	101.2	0		20_	0	
 285,0	101.8	0.6	2.64		25	
 286.0		1.6	_3.07		124	
 	103.8	2.6	3.28		275	
 288.0		3.6	3.32	"	453	
	105.8	4.6	, n.	-	655	
 290.0		5.6	ti :		880	
 291.0	107.8	6.6	"		1,126	

H. WEST WINGWALL SECTION WITH CREST ELEV AT 285.7 FT (BREADTH

 MSL ELEV	Survey Elev	Н	<u> </u>	<u> </u>	Q
 285.7	102.5				
 286.0	102.8	0.3	2.63	65	29
	103.8	1.3	2.89	•	278
288.0		2.3	3.12	'	707
 	105.8	3.3	3.32		1,294
290.0		4.3	1 "	. "	1,924
291.0	107.8	5.3		"	2,633
291.0	107.8	5.3			2,

30 1371 F	20799-19	1
CHK BY BTB	DATE 2-16-79	7
		JD 1 1 20799 - 19 CHK BY DATE BTB Z-16-79

(WEAR WEST END OF DAM)

I. GATED OUTLET WORKS - 7 FT DIAMETER AT UPSTREAM FACE,
INVERT AT ELEV-272.9 FT, ASSUME OUTLET DISCHARGES AS
A SUBMERGED ORIFICE

-	MSL	Survey		A	H	<u>Q</u>	
	2809	97.7	0.7	38.5	1	216	
	281.0	97.8	h	• · · · · · · · · · · · · · · · · ·	1.1	227	والمشهد والالالا
	282.0	98.8	•		2.1	313	a e e
	283.0	· · ·		•	3.1	38!	ge spe
	284.0	100.8		•	4.1	438	
	285.0				5.1	48 8	
	286.0	8.50			6. 1	534	or at Audubia dan Januarya at 100 dalah 1400
Γ.	286.3		- · · · · · · ·		6.4	547	and the second of the second

OUTLET

DISCHARGES GIVEN ABOVE ASSUME ! IS FULLY OPENNED. THE

CATE WORKS ARE OPERABLE BUT NOT USED TO PASS FLOOD FLOWS.

THERE ARE THREE SMALL DIAMETER (4" AND 6") PIPES AT:

THE GATE HOUSE ON THE EAST ABUTMENT. THESE PIPES DELIVER

PROCESS, WATER TO NEARBY FACTORIES AND ARE NOT CONSIDERED

and the second of the second o

COMP. BY JJD 20799 - 19 DATE GOODALL - SANFORD DAM CHK. BY HY DRAULICS 4-10-79 RATING CURVES GODALL - SANFORD DAM 28000 GATED CUTLET 20000 GATED CURET 8 25 687 182 288 **78**7 285 284 283 STAGE (FT. ABONE MSL) D-5 Goodall-Sanford Dam Edward C. Jordan Co., Inc. FORM 00.01 REV. 12/78

PROJECT

JOB NO.

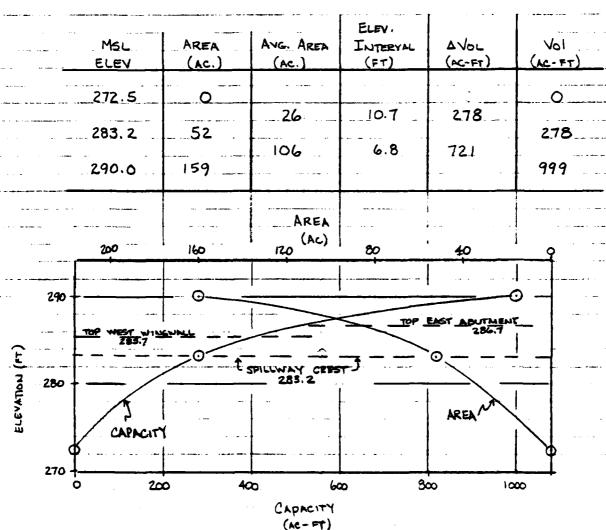
PROJECT	COMP BY	
GOODALL - SAUFORD DAM	JD WHF	20799-19
	CHK BY_	DATE 2-16-79
AREA - CAPACITY DATA	BTB	2-16-79

THE STORAGE OF GOODALL - SAUFORD DAM CONSISTS ENTIRELY OF IMPOUNDED WATER.

AREA - CAPACITY DATA

TIE TO MEAN SEA LEVEL DATUM - FROM ELEVATION DATA GIVEN IN USGS WATER SUPPLY PAPER NO. 1671, THE ELEV OF THE CREST OF THE MAIN SPILLWAY IS 283.2 FT MSL (100.0 FT ON SURVEY DATUM)

HEIGHT OF DAM FROM SPILLWAY CREST (ELEV 283.2 FT) TO DOWNSTREAM STREAMBED = 10.7 FT



D-6 Goodall-Sanford Dam

GOODALL - SANFORD DAM	JHF 4JD	JOB NO. 20799 - 19
TEST FLOOD ANALYSIS	CHK BY BTB	DATE 2-16-79

DRAINAGE AREA - 40.6 SQUARE MILES

HAZARD CLASSIFICATION - HIGH HAZARD
SIZE CLASSIFICATION - SMALL
TEST FLOOD - PMF
DESCRIPTION - FLAT

THE FOLLOWING "PHASE I DAM SAFETY INSPECTION REPORTS" HAVE BEEN COMPLETED FOR DAMS ON THE MOUSAM RIVER UPSTREAM OF THE GOODALL - SANFORD DAM.

DRAINAGE AREA (MIZ)

EMERY MILLS DAM

29.3

MILL STREET DAM

37.8

RIVER STREET DAM

39.3

THE ROUTED 1/2 PMF AT THE OUTLET OF I RIVER STREET DAM = 7,930 CFS

CONTRIBUTION TO 1/2 PMF FROM ADDITIONAL DRAINAGE AREA = 600 CFS

TOTAL 1/2 PMF = 8,530 CFS

THE ROUTED PMF AT THE OUTLET OF THE MILL STREET DAM = 14,540 CFS

CONTRIBUTION TO PMF FROM ADDITIONAL DRAINAGE AREA = 2,520 CFS

(RIVER ST. DAM DOES NOT REDUCE PMF DIE TO

SURCHARGE STORAGE)

TOTAL PMF

D-7 Goodall-Sanford Dam

= 17,060 CFS

PROJECT GOODALL - SANFORD DAN	JOB NO. 20799 - 19
TEST FLOOD ANALYSIS	DATE 2-16-79

ELEVATION - DISCHARGE - STORAGE TABLE

***	MSL ELEV. (FT)	SURCHARGE STORAGE (A-F)	DISCHARGE AT DAM.: (CFS)	
	283.2	0 2	o =	
	284,0	40	355	
	285.0	100	1,300	
	286.0	160	3,246	
	287.0	260	6,820	
	288.0	370	12138	
	289.0	500	17,86 1	
	290. 0		24,480	

AT ELEV 285.7 FT; DAM DISCHARGE = 2,660 CFS , SURCHARGE STOR = 135A-F

AT ELEV 286.7 FT : DAM DISCHARGE = 5,750 CFS , SURCHARGE STOR. = 230A-F

PMF INFLOW = 17,060 CFS

SURCHARGE HEIGHT TO PASS PMF = 5.66 FT (EL 288.9)

VOLUME OF SURCHARGE = STOR, = 487 AC-FT x 1 x 12 = . 22 INCHES 40.6

" EFFECT OF SURCHARGE STORAGE IS INSIGNIFICANT

1/2 PMF INFLOW = 8,530 CFS

HEIGHT TO PASS . 287.3 FT (4.1 FT) STOR, = 293 × 12 = .14 10: --- .14 = .0147

EFFECT OF SURCHARGE STORAGE IS INSIGNIFICANT

ASSUME GATED OUTLET WORKS CLOSED. 2 STORAGE AT SPILLWAY CREST = 278 AC-FT

PROJECT	COMP BY	J08 NO.
	,CTD	20799 - 19
GOODALL - SAUFORD DAM	CHK BY	DATE
TEST FLOOD ANALYSIS	BTB	2-16-79
PMF DATA		•
(1) PMF OUTFLOW AT DAM = 17,000 CF5		
(2) PMF ELEY AT DAM = 288.9 FT		
(3) OVERTOPPING DATA :		
A) WEST ABUTMENT OVERTOPPED BY 3.2	FT,	
B) EAST ABUTMENT OVERTOPPED BY 2.2 FT		
C) LOW POINT OF WEST WINGWALL - 4.5 FT		
D) " " EAST " - 3.8 FT		
(4) SPILLWAY CAPACITY AT TOP OF DAM (EL 285.7) = 2	,230 cfs ((~13% PMF)
V		
1/2 PMF DATA		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
(1) 1/2 PMF OUTFLOW AT DAM = 8,530 CFS		
(2) YZ PMF ELEV AT DAM = 287.3 FT		** ** **
(3) OVERTOPPING DATA		
A. WEST ABUTMENT 1.6 FT		
B. EAST. ABUTMENT - O.G FT		- · - ·
C. LOW POINT OF WEST WINGWALL - 2 D. " EAST - 2		constitution of the same
(4) SPILLWAY CAPACITY AT TOP OF DAM (EL 285.7)	2600	F YZ PMF
Charles and Charles of the country		
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D-9 Goodall-Sanford Dam

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM	220	20799 - 19
· • · · · · · · · · · · · · · · · · · ·	CHK BY	DATE
DAM FAILURE ANALYSIS	BTB	2-16-79

DAM FAILURE ANALYSIS

ASSUME WATER SURFACE ELEVATION AT THE TOP OF THE WEST WINGWALL (EL. 285.7 FT.)

Assume failure of the MAT THE MAIN SPILLWAY SECTION. BASED ON CONVERSATIONS AMONG ENGINEERS INVOLVED IN THE INSPECTION, FAILURE WIDTH WOULD PROBABLY NOT EXCEED 60 FT. IN ADDITION, THE BRIDGE LOCATED ~ 500 UPSTREAM OF THE DAM IS 64 FT. LONG AND THIS WOULD LIMIT FLOW TO THE DAM AT FAILURE WIDTHS GREATER THAN 64 FT.

- (1) STORAGE AT TIME OF FAILURE = 413 AC.-FT
- (2) FAILURE OUTFLOW, Q.

$$Q = 8 \text{ Wb} \sqrt{G} \text{ Yo}^{3/2} = \text{Wb} = 60 \text{ FT}$$
27 Yo = 13.2 FT

= 4,838 CFS

(3) FLOW FROM REMAINDER OF SPILLWAY ONLY INCLUDES DISCHARGE THROUGH SPILLWAY SECTIONS AND NOT OVER WINGWALLS BECAUSE FLOW OVER WINGWALLS MAY NOT REENTER DOWNSTREAM CHANNEL)

...(4) PEAK FAILURE OUTFLOW, QPI

(5) TIME FOR RESERVOIR TO EMPTY, T

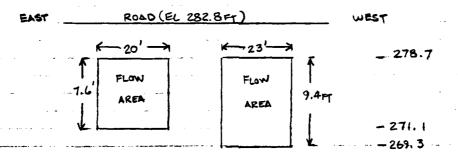
$$T = 12.1 S = 12.1 (413) = 1.5 HOURS$$
 $\frac{12.1 S}{12.06476} = 1.5 HOURS$

FLOW OVER THE CONCRETE DIKE WALLS WILL FLOOD LOW AREAS IN VICINITY OF DAM, AND PROBABLY... NOT REENTER THE MOUSAM RIVER CHANNEL AS A CONTINUOUS FLOW.

D-10 Goodall-Sanford Dam

PROJECT	COMP BY	JOB NO.
GOODALL-SANFORD DAM	- 1212	20799-19
	CHK BY	DATE Z-16-79
DAM FAILURE ANALYSIS	BTB	2-16-79

(LOCATED AT BRIDGE ABOUT 50 FT BELOW DAM)
NOT TO SCALE



- (1) BY MANNINGS EQUATION : (7 = .025 , 5 = .015)
 - A) AT ELEV 278.0 FT , A = 333 , P = 74 , R = 4.5 , Q = 6,540 CFS_
 - IF Q= 6,540 CPS, V = 19.6 FPS (LOOKS EXTREMELY HIGH, MANUFINGS

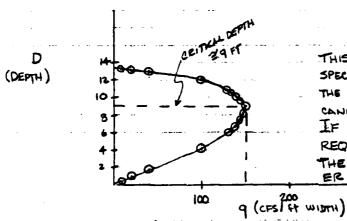
PROBLEY DOES NOT APPLY)

- (2) TRY SPECIFIC ENERGY APPROACH OF RAPIDLY VARIED FLOW .:
 - A) ASSUME HE (SPECIFIC ENERGY) = 13.2 FT-LBS/LB OBTAINED FROM (285.7 272.5) = 13.2 FT

USING CONSTANT - ENERGY RELATION AND HE = D + 92

29 D2

WITH D = DEPTH , 9 = GES/FT WIDTH , 9 = ACC. OF GRAY



THIS GRAPH SHOWS THAT FOR A
SPECIFIC ENERGY OF 13.2 PT-LBS/LB
THE DISCHARGE PER FOOT OF WIDTH
CANNOT EXCEED 150 CFS/FT WIDTH,
IF FLOW > 150 CFS/FT WIDTH ARE
REQUIRED TO PAGS FLOW FROM FAILURE,
THE BRIDGE WILL PRODUCE BACKWATER EFFECTS AND CAUSE ORIFICE FLOW
, 300 AT THE CULVERTS

D-11 Goodall-Sanford Dam

PROJECT	COMP BY	JOB NO.
GOODALL - SANPORD DAM	110	20799-19
DAM FAILURE ANALYSIS	CHK BY BTB	DATE
DAM TATCORE ANACISIS	BTB	2-16-79

TOTAL WIDTH OF CULVERTS = 43 FT

PEAK FLOW FROM FAILURE = 6,500 CFS

.. 9 REQUIRED = 6,500/43 = 151 CFS/FT OF WIDTH

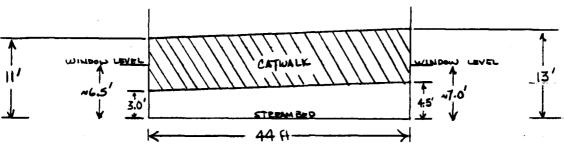
BOTH OPEN CHANNEL FLOW METHODS AGREE CLOSELY, THEREFORE, ASSUME PEAK FLOW FROM FAILURE CAN PASS UNDER BRIDGE UNDER OPEN CHANNEL FLOW CONDITIONS.

D-12 Goodall-Sanford Dam

PROJECT
GOODALL - SANFORD DAM
DAM FAILURE ANALYSIS

1	COMP. BY	JOB NO. 20149 - 19
	CHK. BY	DATE 2-16-79

CROSS - SECTION #2 (AT CATWALK LOCATED ~ 250 FT BELOW DAM)



STREAMBED AT APPROX. ELEVATION OF 268 FEET MSL

NOTE: CATWALK SIDES AND ROOF ARE CONSTRUCTED OF THIN SHEET METAL AND IS SUPPORTED BY 12" AND 8" STEEL" I" BEAMS, FLOOD WATERS IMPACTING THE CATWALK WOULD PROBABLY SEVERELY DAMAGE

AND WASH OUT THE SHEET METAL PORTIONS OF THE STRUCTURE.

CHECK OPEN- CHANNEL FLOW (1 = .035 , 5 = .015)

STAGE	AREA	WETTED PERIM.	HYDEAULC EADIUS	SLOPE	1.486/21	<u> </u>
(FY)	Utt		tion of a sea Park Committee of the Apparent of the	gerrander Sauce	man ye rer	(c b)
2	88	48	1.83	.015	42.5	682
4	176	\$2	3.38	u	14	2,047
6	264	56	4.71	, 4		3,821
8	352	60	5.87	14	14	5,892
10	440	64	6.88	j4	te .	8,175

PRIOR TO FAILURE, STAGE \$4 ft.

AFTER FAILURE, STAGE \$8 ft (ABOVE WINDOW LEVELS)

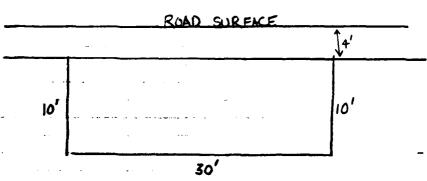
D-13 Goodall-Sanford Dam

ASSUME CATWALKS ARE WASHED OUT (SHEET METAL PORTIONS), .: OPEN - CHANNEL FLOW WOULD RESULT

ROJECT					COMP BY	108 NO. 20799 - 19		
Goodall - Sanfo	ird La	M			CHK BY	DATE	┤	
DAM FAILURE AL	1 KLYSIS				BTB	2-19-79] .	
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CROSS - SECTION	ON CON	SISTS C	of A So	FT LONG	S DAM a	2 WATER	•	
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PARKING LOT AND						Digital in the		
DRIVE	,					PARKING LOT		
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PROJECT		J08 NO.
GOODALL - SANFORD DAM		20799 - 19
l .		DATE
DAM FAILURE ANALYSIS	BTB	2-16-79

CROSS-SECTION #4							
(LOCATED APPROX 2,500 FT	BELOW DAM AT	BRIDGE	CROSSING)				



CAPACITY UNDER BRIDGE ASSUMING OPEN CHANNEL FLOW :

A = 300 , P = 50 , R = 6.00 , - Q = 3,690 CFS

CHANNEL FLOW CONDITIONS, FLOW PRIOR TO FAILURE WOULD

FOR ORIFICE FLOW:

C = 0.6 A = 300

H = 4

... Q = CA√2gH = 2890 CFS

BRIDGE WILL BE OVERTOPPED

NO SIGNIFICANT CHANNEL STORAGE ABOVE BRIDGE SECTION

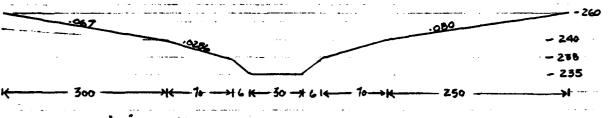
PROJECT	COMP BY		\Box
GOODALL - SANFORD DAM	JJD	20799 - 19	
·		DATE	\neg
DAM FAILURG ANALYSIS	BTB	2-16-79	

CROSS - SECTION #5

(~1.2 MILES BELOW DAM, ABOVE SCHOOL ST)

(LOOKING UPSTREAM)

ELEVATIONS ARE APPROXIMATE



-		1	r ·	f			
سدية فيتستنفس لروادا				<u></u>		_1,486	W.S.
<u></u>	Q	5	R	P	A	×	ELEV
	152	.00095	2.51	43	108	24.8	238
	375		1.81	183	•	•	240
	3,494	•	4.95	321	1,590_		245
	5,743		6.07	.374	2,284		247
	7,199		6.63	403	2,672		248
		1	ł		Ī		

$$V_1 = (6300 - 2500)(2478) = 216 \text{ K-FT} (~50\% \text{ of 5})$$

$$= 43,560$$

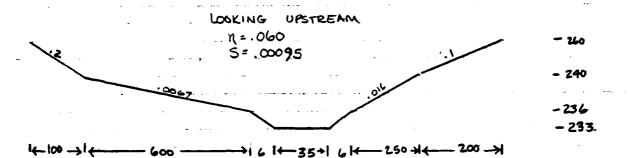
$$q_2 = 6,500 \left(1 - \frac{216}{413}\right) = 3,100 \text{ cFs}$$

$$Q_5 = 6,500\left(1 - \frac{171}{413}\right) = 3,809 \text{ cfs}$$

D-16 Goodall-Sanford Dam

PROJECT	COMP BY	JOB NO. 20799 - 19
GOODALL - SAUFORD DAM	CHK BY	DATE
DAM FAILURE ANALYSIS	BTB	2-16-79

(~1.5 MILES BELOW DAM, BELOW SCHOOL ST)



	W.S.	1.486							
_	ELEV	7	A	ρ	R	S_	0	-	
*****	236	24.8	123	48	2.56	.00095	176		
	Z38_	"	642	473	1.36	"	600		
	240	н	2,011	898	2.24		2,617		
	241	la	2,916	913	3,19.		4,830		
	- - -					.			
							1		

$$S = 413 \text{ AC-FT}$$
 $q_1 = 3,809 \text{ CFS}$
 $V_1 = (1,694 + 2,464)(1600) = 76 \text{ AC-FT}$
 $V_2 = (3,500)$

$$q_2 = 3809 \left(1 - \frac{76}{413}\right) = 3,108 \text{ CFS}$$

$$V_2 = \left(\frac{1,430 + 2212}{2}\right)\left(\frac{1600}{2}\right) = 67 \text{ K-FT}$$

$$= \frac{43,560}{2}$$

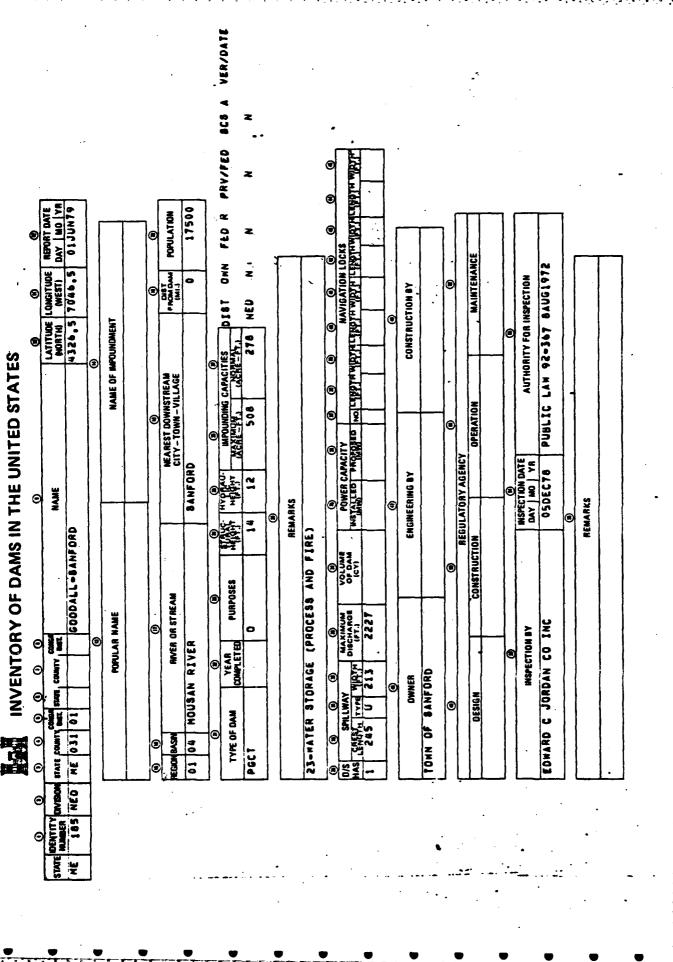
$$Q_6 = 3809 \left(1 - \frac{72}{413}\right) = 3,145 \text{ CFS}$$

STAGE = 7.2 FT (EL 240.2 FT)

SEVERAL HOUSES IN THIS AREA WOULD BE FLOODED TO DEPTHS OF I TO 3 FEET. THERE IS NO HAZARD BELOW THIS SECTION.

D-17 Goodall-Sanford Dam

APPENDIX E Information as Contained in the National Inventory of Dams



END

FILMED

7-85

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